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A NEW SPECIES OF *ELEUTHERODACTYLUS* FROM NORTHERN ECUADOR (AMPHIBIA: LEPTODACTYLIDAE)

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Abstract.—*Eleutherodactylus loustes,* new species, is described from intermediate elevations on the Pacific versant of the Andes in northern Ecuador. The new species exhibits a combination of character states intermediate between those of frogs of the *fitzingeri* and *unistrigatus* groups and differs from all congeners in having toe webbing, areolate skin on the venter, and the first finger longer than the second. Its closet relatives are *E. crenunguis* Lynch and *E. latidiscus* (Boulenger) from the Pacific versant and *E. cremnobates* Lynch and Duellman and *E. rubicundus* (Jiménez de la Espada) from the Amazonian versant.

Lynch (1976a) defined the species groups of *Eleutherodactylus* in South America primarily on the basis of relative lengths of the inner two fingers and the texture of the skin on the venter. The two largest species groups he recognized in South America were the *fitzingeri* group (ca. 40 species) and the *unistrigatus* group (ca. 100 species). Lynch (1976b) and Lynch and Duellman (1979) named two species which strained those group definitions. *Eleutherodactylus crenunguis* was placed in the *fitzingeri* group by Lynch (1976b) who noted its resemblance to *E. cruentus* (Peters) and *E. latidiscus* (Boulenger). Lynch and Duellman (1979) removed *E. crenunguis* to the *unistrigatus* group, named *E. cremnobates,* and considered these two species closely related to one another as well as to *E. rubicundus* and *E. latidiscus*; the four species were placed in the *rubicundus* assembly within the *unistrigatus* group.

During field work in northern Ecuador in May 1977, an additional species of this complex was found. It differs trenchantly from the four species known to date in having appreciable toe webbing.

The following abbreviations are employed: SVL (snout-vent length), IOD (interorbital distance), E-N (eye to nostril distance), and KU (University of Kansas Museum of Natural History).

Eleutherodactylus loustes, new species
(Figs. 1, 2)

Holotype.—KU 179234, an adult female, one of a series collected at Maldonado, Provincia Carchi, Ecuador, 1410 m, on 29 May 1977 by Thomas Berger, David Cannatella, and John Lynch.

Fig. 1. *Eleutherodactylus loustes* (KU 179233), adult male, 31.2 mm SVL; from Kodachrome by author.

Paratypes.—KU 179231–33, 179235–50, collected at the type locality on 29 and 30 May 1977.

Diagnosis.—1) skin of dorsal surfaces smooth except for anastomosing ridgelets on lower back and prominent fold between eyes, that of venter areolate; no dorsolateral folds; 2) tympanum concealed beneath skin, annulus small; 3) snout round in dorsal view, angularly rounded in lateral profile; 4) upper eyelid broader than IOD, bearing low warts; low cranial crests palpable; 5) vomerine odontophores elevated, oval; 6) males with vocal slits and subgular vocal sac; no nuptial pad on thumb; 7) first finger slightly longer than second; fingers II–IV bearing enlarged pads; all pads bearing broad discs; 8) fingers bearing distinct lateral fringes; 9) no ulnar tubercles except small antebrachial; 10) no tubercles on heel or tarsus; flap-like inner tarsal fold on distal ⅖–½ of tarsus; 11) two metatarsal tubercles, inner oval, 8 times size of subconical outer; 3–6 indistinct supernumerary plantar tubercles; 12) toes bearing prominent flap-like lateral fringes, webbed—modal formula I 2^{-}—2 II 1⅔—3^{-} III 2^{+}—3½ IV 3½—2^{+} V; fringe along outer edges of toes I and V; toe pads smaller than those of outer fingers; 13) brown above with darker brown markings on occiput and sacrum; labial and limb bars, canthal-supratympanic stripes dark brown; anterior and posterior surfaces of thighs brown; throat gray; venter cream with diffuse brown reticulation; 14) adults large, males 31.2–37.1 ($\bar{x}$ = 34.8, N = 6), one adult female 46.7 mm SVL.

Eleutherodactylus loustes is distinguished from its nearest relatives (*E. cremnobates, E. crenunguis, E. latidiscus* and *E. rubicundus*) by virtue of its toe webbing and inner tarsal fold.

Description.—Head as wide as (or wider than) body; head wider than long; head width 38.0–40.9 ($\bar{x}$ = 39.5, N = 10) percent SVL; snout suba-

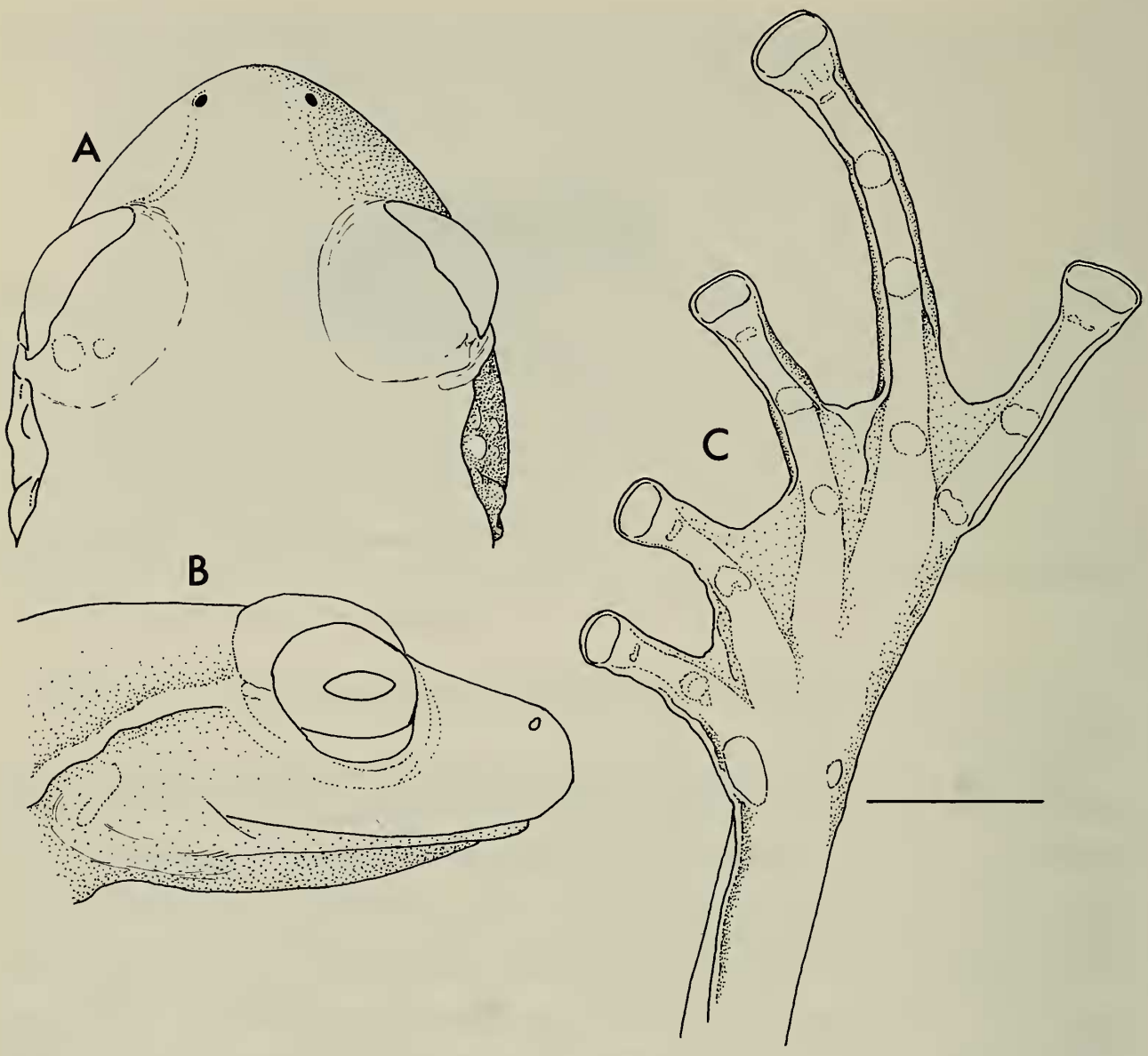

Fig. 2. *Eleutherodactylus loustes*. **A, B**, dorsal and lateral views of head, KU 179242; **C**, ventral view of foot, KU 179243. Line equals 5 mm.

cuminate to round in dorsal view, angularly rounded in lateral profile; nostrils weakly protuberant, directed dorsolaterally; snout short, E-N of males 67.8–81.6 ($\bar{x}$ = 74.8, N = 6) percent eye length, of females 85.2–91.5 ($\bar{x}$ = 88.7, N = 4) percent; canthus rostralis evident but rounded, weakly concave (Fig. 2); loreal region concave, gently sloping to lips; lips not flared; interorbital space narrow, bearing an interocular ridge with a median tubercle; cranial crests palpable; upper eyelid width 100.0–150.0 ($\bar{x}$ = 121.5, N = 10) percent IOD; low, non-elevated tubercles on upper eyelids; thick supratympanic fold from posterior corner of eye to above insertion of upper arm; postrictal tubercles large, elevated; tympanic annulus concealed beneath thick skin of side of head (Fig. 2); choanae large, oval, longer than wide, not concealed by palatal shelf of maxillary arch when roof of mouth is viewed from directly below; vomerine odontophores elevated, oval, me-

dian and posterior to choanae, separated by a distance equal to between ⅔ and a full width of an odontophore, each slightly larger than a choana, bearing a transverse row of 4–5 teeth in males, 7–8 teeth in large females; tongue large, as long as wide, posterior edge deeply notched, posterior ⅕ not adherent to floor of mouth; males having long vocal slits posterolateral to tongue; vocal sac external, subgular, single.

Skin of dorsal surfaces smooth except for small anastomosing ridges; vent extended in a sheath to level of posterior edge of thigh but not going down on to back of thighs; skin of venter areolate; throat smooth except for small, white warts; forearm bearing small antebrachial tubercle, but no other ulnar tubercles; palmar tubercles low; palmar tubercle bifid, twice as large as oval thenar tubercle; supernumerary palmar tubercles large, diffuse; subarticular tubercles low, round; fingers bearing keel-like lateral fringes and large pads (2–3 times width of digit below pad) bearing broader than long discs on fingers II–IV; pad of thumb small but bearing broad disc; all pads and discs apically rounded (not emarginate); male lacking nuptial pad on thumb; first finger longer than second.

Heel lacking tubercles or bearing one indistinct tubercle; outer edge of tarsus lacking tubercles; inner edge of tarsus bearing strong (flap-like) inner tarsal fold along distal ⅖ to ½ of tarsus; inner metatarsal tubercle flat, oval, outer metatarsal tubercle subconical, ⅛ size of inner; plantar supernumerary tubercles indistinct (if present at all); subarticular tubercles not elevated; prominent fringe along inner edge of toe I and lesser fringe along outer edge of toe V; toe pads slightly smaller than those of outer fingers; toes basally webbed (Fig. 2), free portions of toes bearing very prominent lateral fringes; webbing formulae (following Savage and Heyer, 1967) for males I (2–2^-)—(2^+–2) II (1⅔–1½)— (3^-–2^-) III (2¼–2)—(3⅔–3⅓) IV (3½–3¼)—(2⅕–2) V, for females I 2^-—(2^+–2) II (1⅔– 1½)—(2½–3^-) III (2^+–2^-) —(3⅔–3½) IV 3½—(2^+–2^-) V; shank of males 56.8–63.1 ($\bar{x}$ = 59.2, N = 6) percent SVL, of females 58.8–61.3 ($\bar{x}$ = 60.4, N = 4) percent.

Ground color brown; body bearing dark brown occipital W-shaped mark, interorbital bar, broad sacral chevron (almost a band); occipital W bearing indistinct ridges outlined with cream; interorbital bar bearing cream line along anterior border; sacral chevron outlined in cream; dark bars on thighs brown separated by pale brown interspaces which are subdivided by dusky brown lines; posterior surfaces of thighs dusky brown; dark brown bars on shanks as wide as (or slightly narrower than) pale brown interspaces, shank bars more or less perpendicular to limb axis; canthal-supratympanic stripe and labial bars dark brown; indefinite slanted bars on flanks; anterior surfaces of thighs brown with small cream spots; throat gray with white flecks; venter cream with diffuse brown reticulation; throat and venter pigmentation separated by diffuse brown V-shaped mark; undersides of limbs gray flecked with white and bearing diffuse brown reticulation.

In life, *E. loustes* is colored as follows: "Large female: reddish brown with black spots. Some green wash on spaces between leg bars and on lower flank. Concealed thigh black with greenish speckles. Iris deep brown. Venter cream with brown spots. Throat brown with cream flecks. Toe webs pale yellow-green. Male: green with gold or copper wash, especially anteriorly. Iris more coppery [otherwise like female]" (J. D. Lynch fieldnotes 29 May 1977).

Measurements of holotype in mm.—SVL 46.7; shank 28.5; head width 19.1; head length 16.1; upper eyelid width 4.5; IOD 3.3; eye length 6.0; E-N 5.3.

Natural history.—Specimens were collected on the nights of 29 and 30 May 1977 on bare rock faces, moss encrusted rocks on the floor of the stream, and on leaves in the spray zone of a waterfall. The small stream (a tributary of the Quebrada Naranjo) was heavily shaded by forest. When approached with a headlamp the frogs crouched against the wet substrate. Collecting one hundred meters on either side of the small waterfall failed to yield additional specimens nor were specimens encountered in seemingly similar microhabitats along the nearby Quebrada Huagambí (both debauch into the Río San Juan within 200 m). No evidence of reproductive activity was noted although males have swollen testes. Two females (JDL 8641–42) are slightly smaller (44.9 and 46.0 mm SVL) than the holotype and have feebly convoluted oviducts.

Etymology.—Greek, meaning one fond of bathing. The name is in loose allusion to the frogs being found only within the spray zone of a waterfall in a deep, cool canyon.

Sympatric congeners.—In addition to *E. loustes, E. achatinus* (Boulenger), *E. chalceus* (Peters), *E. calcarulatus* Lynch, *E. necerus* Lynch, and *E. w-nigrum* (Boettger) were secured in five nights of fieldwork (27–31 May 1977). One other species found at Maldonado is being described separately (Lynch and Myers, MS). None of these were found in the same microhabitat as *E. loustes*.

Discussion.—Lynch and Duellman (1979) suggested that *E. crenunguis* (Pacific) and *E. rubicundus* (Amazonian) were a species pair in the *rubicundus* assembly and that *E. cremnobates* (Amazonian) and *E. latidiscus* (Pacific) were a second pair. *Eleutherodactylus loustes* is much more similar to *E. crenunguis* and *E. rubicundus* than to *E. cremnobates* or *E. latidiscus*.

All five species share the following character states: interorbital space narrow, cranial crests present (usually adult females only), fingers and toes long and slender and bearing large pads (and broad discs); vomerine odontophores prominent; canthus rostralis obsolete (not sharp); loreal region sloping gently to lips. The tympanic annulus is small in all species but is concealed beneath the skin only in *E. loustes*. That species also differs from

Table 1. Character states in the five species of the *rubicundus* assembly of the *unistrigatus* group of *Eleutherodactylus* (× = yes, ○ = no).

	cremnobates	*crenunguis*	*latidiscus*	*loustes*	*rubicundus*
Male with vocal slits	○	×	○	×	○
First finger > second	○	×	○	×	×
Venter finely areolate	×	○	×	×	×
Digital pads emarginate	○	×	×	○	×
Heel and tarsal tubercles	×	×	○	○	×
Lateral fringes on fingers	×	○	×	×	○

the others in having toe webbing, prominent toe fringes, and a flap-like inner tarsal fold.

All five species are nocturnal. *Eleutherodactylus cremnobates, E. loustes,* and *E. rubicundus* are found in very wet areas (often spray zones or drip zones) along small rocky streams (0.5–1.5 m wide) in dense cloud forests. *Eleutherodactylus crenunguis* is sometimes encountered in such situations but is more frequently found in forest-edge microhabitats. *Eleutherodactylus latidiscus* is a lowland forest species and specimens have accumulated slowly. The apparent rarity may reflect the frogs' preference for a higher stratum in the forest than that normally searched. Richard Zweifel obtained a calling male 4 meters above ground on "a 6″ diameter partly hollow and branchless snag, laden with bromeliads."

Those characteristics readily reduced to discrete character states (Table 1) do not obviously correlate with the ecological notes now available for the five species (nor do they readily correlate with my views on the relationships among the five species). However, neither do they sort the taxa geographically.

Collections of eleutherodactyline frogs in Ecuador are extensive and although much data remain to be published (including approximately 25 undescribed species), no other eleutherodactyline species are known to me that might be closely related to this assembly of five species. A critical point is the absence of *rubicundus* assembly frogs at elevations above 1700 meters. The reported distribution of *E. latidiscus* covers eastern Panama, western Colombia, and northwestern Ecuador (Cochran and Goin, 1970) but the Panamanian material as well as much of the Colombian material is misidentified. I have examined *E. latidiscus* as far north as the drainage of the Río San Juan in Colombia and as far south as the Río Palenque Biological Station in southern Provincia Pichincha in Ecuador. Cochran and Goin's (1970) *E. latidiscus tamsitti,* if distinct, establishes the occurrence of the species in the headwater regions of the Río Magdalena.

The presence of two sets of species found in low cloud forests on opposite

sides of the Ecuadorian Andes where each set has trans-Andean and cis-Andean representatives poses a clue to the role of the Andes in the impressive speciation of *Eleutherodactylus* in northwestern South America. The distributional and phylogenetic patterns suggest that the Andean orogeny isolated the *crenunguis-loustes* and the *latidiscus* stocks from those of *rubicundus* and *cremnobates* respectively.

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Literature Cited

Cochran, D. M., and C. J. Goin. 1970. Frogs of Colombia.—U.S. Nat. Mus. Bull. 288, 655 pp.

Lynch, J. D. 1976a. The species groups of the South American frogs of the genus *Eleutherodactylus* (Leptodactylidae).—Occ. Pap. Mus. Nat. Hist. Univ. Kansas 61:1–24.

———. 1976b. New species of frogs (Leptodactylidae: *Eleutherodactylus*) from the Pacific versant of Ecuador.—Occ. Pap. Mus. Nat. Hist. Univ. Kansas 55:1–33.

Lynch, J. D., and W. E. Duellman. 1979. The *Eleutherodactylus* of the Amazonian slopes of the Ecuadorian Andes (Anura: Leptodactylidae).—Misc. Publ. Univ. Kansas Mus. Nat. Hist. *in press*.

Savage, J. M., and W. R. Heyer. 1967. Variation and distribution in the tree-frog genus *Phyllomedusa* in Costa Rica, Central America.—Beit. Neotrop. Fauna 5:111–131.

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